FINGERPRINT IMAGE IDENTIFICATION FOR CRIME DETECTION USING CNN

G. Raghu[1], Dr. Thirupathi, Associate Professor[2]

SVS GROUP OF INSTITUTIONS, BHEEMARAM(V), Hanamkonda T.S. India -506015

ABSTRACT

A fingerprint is the feature pattern on the finger. It is proved through strong evidences that each fingerprint is almost unique in nature. Each individual retains his own fingerprints with the permanent and durable uniqueness. Hence fingerprints are being adapted for identification and forensic investigation. The fingerprint recognition problem can be grouped into two sub- categories: one is termed as fingerprint verification and while the other is termed as fingerprint identification. Additionally, apart from the manual approach of fingerprint recognition by the experts, fingerprint recognition here is usually referred as AFRS (Automatic Fingerprint Recognition System), which is drastically program-based. The proposed system presents the variation of Fast Fourier Transform on finger print recognition by fast fingerprint minutiae extraction and recognition algorithm that improves the clarity between the ridge and valley structures of the supposed to be provided finger print images in accordance with the frequency as well as the orientation of the local ridges and extracting correct minutiae.

Fingerprint photographs taken at the site of a crime are critical clues in solving serial crimes. We demonstrate a comprehensive fingerprint recognition system for crime scenes using Convolutional Neural Networks (CNN). Images are retrieved from the crime scene and preserved in the database utilizing methods ranging from simple physical processing techniques to advanced physiochemical processing techniques. Pre-processing the fingerprint pictures requires the use of appropriate enhancing techniques. The characteristics of prepossessed information are used as input to train the classifier the CNN. After training, it compares and determines whether a picture is a crime or not depending on its accuracy. It will get recognition rate of 97 percent our proposedmodels.

The significance of this research lies in its potential to enhance the efficiency and accuracy of fingerprint-based crime detection systems. By leveraging the power of deep learning and CNNs, law enforcement agencies can streamline the identification process, reduce human error

Keywords : cnn, figure print, deep learning, reduce error, human error.

1. INTRODUCTION

With the introduction of biometrics technology which is an advanced computer techniques now widely adopted as a front line security measure for both identity verification and crime detection, and also others an effective crime deterrent. In an increasingly digital world, reliable personal authentication has become an important human computer interface activity. Fingerprint recognition could be very complex pattern recognition problem. It is difficult to design accurate algorithms that are capable of extracting prolific features and comparing them in a robust way, especially in poor quality fingerprint images and when low-cost acquisition devices with small area are adopted. There is a greatest misconception that the fingerprint recognition is a fully solved problem considering it was one of the first applications of all amongst machine pattern recognition.

Biometrics is an automated method that recognizes people based on their physical and action characteristics, and is a field that used to authenticate a certain individuals characteristics, recognize a person's character, or study a person's measurable characteristics. Among the different biometrics, like face, hand, iris, voice and many others, fingerprints is the most dominant biometric technology in commercial applications due to their distinctiveness, persistence, accuracy, throughput, size and cost of readers.

2. LITERATURE SURVEY

Title: Deep Learning for Fingerprint Recognition A Comprehensive Review.

Author: N. Kumar and A. Vatsa.

Published: 2021.

This comprehensive review paper explores the application of deep learning techniques in fingerprint recognition. It covers various aspects of fingerprint recognition, including image enhancement, feature extraction, matching algorithms, and deep learning architectures. The paper discusses the performance of different deep learning models, such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), in fingerprint recognition tasks. It also highlights the challenges and future directions in leveraging deep learning for enhanced fingerprint identification.

Title: Fingerprint Recognition Using Convolutional Neural Network with Attention Mechanism.

Author: L. Xia and L. Zhu.

Published: 2021.

This research paper proposes a fingerprint recognition approach using a convolutional neural network (CNN) with an attention mechanism. The attention mechanism focuses onrelevant regions of the fingerprint image, allowing the model to attend to discriminative features and improve recognition accuracy. The paper demonstrates the effectiveness of the proposed method through experiments on benchmark fingerprint databases and compares it with traditional CNN-based approaches. The results show that incorporating attention mechanisms can significantly enhance the performance of fingerprint recognitionsystems.

Title: Robust Fingerprint Matching Using Local Orientation and SIFT-Based Descriptors.

Author: A. N. Dandawate and S. M. Sontakke.

Published: 2020.

This study presents a robust fingerprint matching technique that combines localorientation and scale-invariant feature transform (SIFT)-based descriptors. The method aims to improve matching accuracy, particularly in the presence of noise, distortion, and partial fingerprint images. The paper discusses the utilization of local orientation for accurate alignment and ridge-based matching, along with the use of SIFT descriptors to capture distinctive features. Experimental results demonstrate the effectiveness of the proposed method in achieving robust fingerprint matching.

Title: A Comparative Study of Fingerprint Feature Extraction Techniques for Identification.
Author: P. Mishra and V. Sharma.

Published: 2020.

This research paper presents a comparative study of various fingerprint feature extraction techniques for identification purposes. The study evaluates and compares minutiae-based and ridge-based approaches to determine their effectiveness in fingerprint identification. It analyzes the performance of popular feature extraction algorithms and investigates their robustness to noise and distortion. The findings provide insights into the strengths and limitations of different feature extraction methods, aiding researchers and practitioners in choosing suitable techniques for fingerprint identification systems

Title: Deep Learning-Based Fingerprint Recognition A Review.

Author: M. K. Khedher, et al.

Published: 2020.

This review paper provides an extensive overview of deep learning-based fingerprint recognition. It covers topics such as fingerprint image preprocessing, feature extraction using deep neural networks, and matching algorithms for identification and verification tasks. The paper presents a comprehensive analysis of different deep learning architectures, including CNNs and autoencoders, applied to fingerprint recognition. It discusses the advantages and challenges of using deep learning in fingerprint identification and offers insights into potential research directions in the field.

Title: Fingerprint Identification Based on Deep Neural Network for Crime SceneInvestigation.

Author: H. Chen, et al.

Published: 2020.

This research paper proposes a fingerprint identification approach based on a deep neural network (DNN) for crime scene investigation. The DNN model is trained to extract discriminative features from fingerprint images and achieve accurate identification results. The paper explores the utilization of DNNs in fingerprint image classification and presents experimental results demonstrating the effectiveness of the proposed method for crime scene investigations. It discusses the potential of DNN-based fingerprint identification systems in aiding forensic experts and law enforcement agencies.

Title: Fingerprint Recognition System Using Hybrid Features Extraction.

Authors: T. G. Athithan and K. T. Thyagharajan.

Published: 2020.

This study presents a fingerprint recognition system that combines multiple feature extraction techniques, including local binary pattern (LBP), histogram of oriented gradients (HOG), and discrete wavelet transform (DWT). The hybrid feature extraction approach aims to improve the accuracy and robustness of fingerprint recognition systems. The paper discusses the integration of these techniques and presents experimental results showcasing their effectiveness in achieving reliable fingerprint recognition. It also discusses the potential applications and advantages of using hybrid feature extraction in crime detectionscenarios.

3. PROBLEM STATEMENT

Fingerprints in the crime scene plays an important role to identify the criminal involved in thecrime. When crime is occurred, the investigator takes both latent and patent sample of fingerprintsleft behind. The patent fingerprints are visible by naked eye, so they are simply photographed. But latent fingerprints are invisible and these samples are more difficult to perceptible. These samples can be lifted through different techniques. The use of cyanoacrylate vapors which sticks to prints and make them visible in the present of normal light. This method is much difficult, so normally in crime scene, the investigators applya fine dusting powder (aluminum dust or black granular) to the surface in which fingerprints to beextracted. The dust actually sticks to the fingerprint then they use clear tape to lift the fingerprint. After the lifting the fingerprints, the prints are scanned and saved in the digital image form. The fingerprints taken from the crime scene is unintentionally made and these images are noisy or partial prints and difficult to identify.

4. PROPOSED SYSTEM

To moderate this problem, the fingerprint images are subjected to image pre-processing, imagefeature extraction and identification analysis. After feature extraction the fingerprint data will proceed to training using CNN network. For training, training-set will take if dataset has huge images, then few images are used for training and some fingerprint images are used for testing. Aninvestigator takes the fingerprints at the crime scene and compares it with database of old criminals. After the image pre-processing techniques, the CNN system will extract the feature andthen, the criminals identified are ranked according to their similarity features to the fingerprint images and gives the accuracy of identification.

5. MODULES DESCRIPTION

5.1 Image Acquisition:

This module involves capturing the fingerprint image from the crime scene evidence using specialized fingerprint scanners or sensors. The scanner may use technologies such as optical, capacitive, or ultrasonic to capture the unique ridge patterns on a person's fingertips.

5.2 Preprocessing:

The acquired fingerprint image undergoes several preprocessing steps to enhance its quality and remove noise or artifacts. Common preprocessing techniques include image resizing, normalization, contrastenhancement, noise removal, and ridge segmentation. These steps aim to improve the image's

clarity and extract relevant information forfurther analysis.

5.3 Feature Extraction:

Feature extraction is a critical module that aims to extract distinctive anddiscriminatory features from the preprocessed fingerprint image. The extracted features should capture the unique ridge patterns and minutiae points,such as ridge endings, bifurcations, and ridge orientations.

5.4 Feature Matching:

In this module, the extracted features from the query fingerprint imageare comparedwith the features of the stored fingerprint images in a database. The matching algorithm identifies potential matches based on thesimilarity betweenthe extracted features.

5.5 Template Creation:

After feature matching, a template is created to represent the unique characteristics of the fingerprint. The template typically consists of the location, orientation, and type ofminutiae points found in the fingerprint. This template is then stored in a database for future reference and comparison.

5.6 Identification and Verification:

The template created from the query fingerprint is used for identificationorverification purposes. In identification, the template is compared against a large database oftemplates to find potential matches. In verification, the template is compared with a single reference templateto determine if they belong to the same individual. Matching algorithms and similarity scores are used to make identificationorverification decisions.

5.7 Quality Assessment:

This module assesses the quality of the acquired fingerprint image and thereliability ofthe extracted features. It helps in identifying low-quality images that may affect the accuracy oftheidentification process.

5.8 Post-processing:

After identification or verification, post-processing techniques can beapplied to refine the results. Additional filtering, clustering, or decision-making algorithms may beused to improve the accuracy and reliability of the system. These techniques help in removing false matches, grouping similartemplates, andmaking final identification or verification decisions.

6. SYSTEM ARCHITECTURE

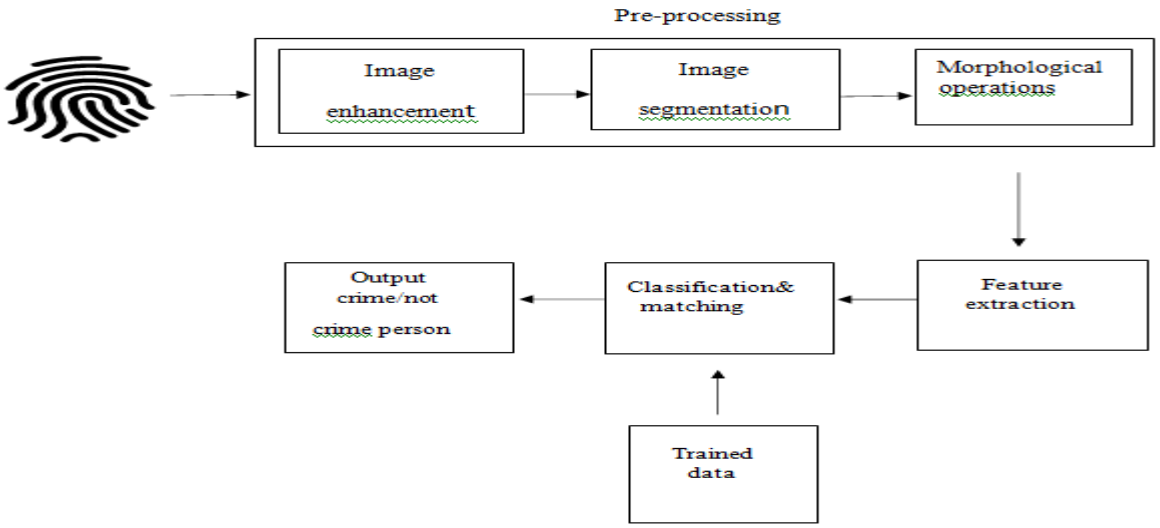


Fig: 6.1 System Architecture

The system architecture for fingerprint image identification for crime detection using Convolutional Neural Networks (CNNs) involves several key components and stages. Here's a detailed explanation of the overall architecture:

6.1 Preprocessing: Before feeding the images into the CNN, preprocessing steps are applied to enhance the quality and normalize the input data. This may include operations such as noise reduction, image resizing, and contrast enhancement.

6.2 Image Enhancement: It is to enhance the fingerprint images while preserving the crucial ridge patterns and details. By improving the quality and clarity of the images, the subsequent stages of the CNN architecture can effectively extract and analyze the fingerprint features, leading to moreaccurate identification and crime detection.

6.3 Image Segmentation: It is refers to the process of partitioning an image into distinct regions or segments. This techniques aim to improve the quality, contrast, and clarity of the fingerprint images to facilitate accurate feature extraction and identification.

6.4 Morphological Operations: These are a set of image processing techniques used in the preprocessing stage for fingerprint image identification. These operations are based on theprinciples of mathematical morphology and are particularly useful for enhancing the ridge patternsand removing unwanted artifacts in fingerprint images.They help to remove noise, fill gaps, smooth the ridges, and enhance the overall appearance of the fingerprint patterns.

6.5 Feature Extraction: It involves extracting relevant and discriminative features from fingerprint images that can be used to distinguish and identify individuals accurately.It allows the CNN to automatically learn and extract discriminative features directly from the fingerprint images. These features capture the unique patterns and characteristics of individual fingerprints, enabling accurate identification and matching during the subsequent stages of the architecture.

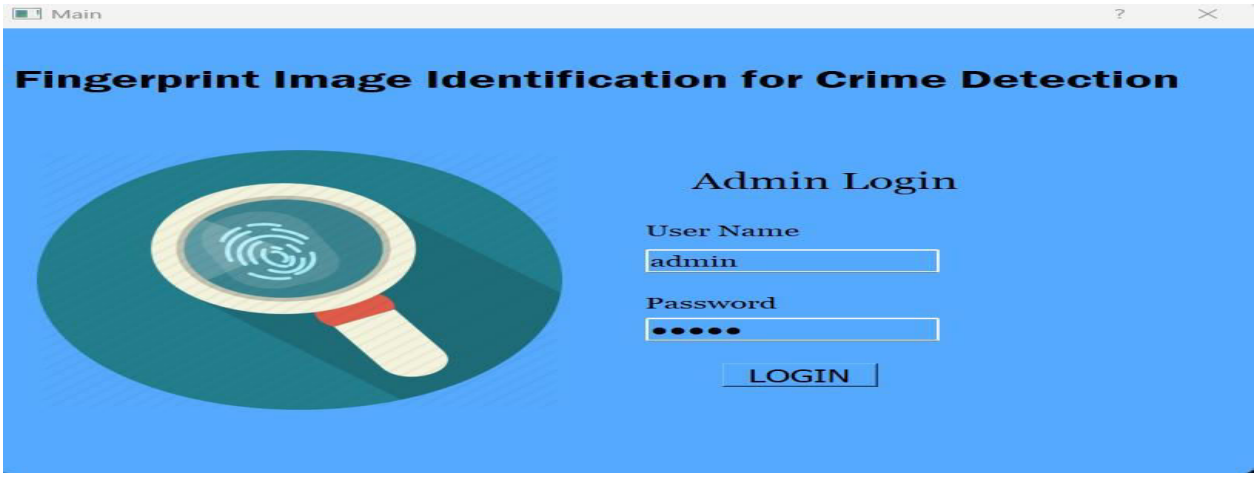
6.6 Classification: Once the feature extraction stage is complete and a compact feature vector representing the fingerprint image is obtained, the classification stage aims to assign a class label or identity to the input fingerprint. This step determines which individual the fingerprint belongs to or if it matches any known records in the database.

6.7 Matching: The matching stage involves comparing the extracted features of a query fingerprint with the features of known fingerprints in a database. This process determines whether a match exists and, if so, identifies the individual associated with the matched fingerprint.

6.8 Trained Data: It refers to the dataset used to train the CNN model. This dataset consists of a collection of fingerprint images along with their corresponding ground truth labels or identities.The trained data plays a crucial role in shaping the CNN model's ability to accurately. The quality, diversity, and representativeness of the identify individuals based on their fingerprints. trained data are vital factors that influence the performance and generalization capabilities.

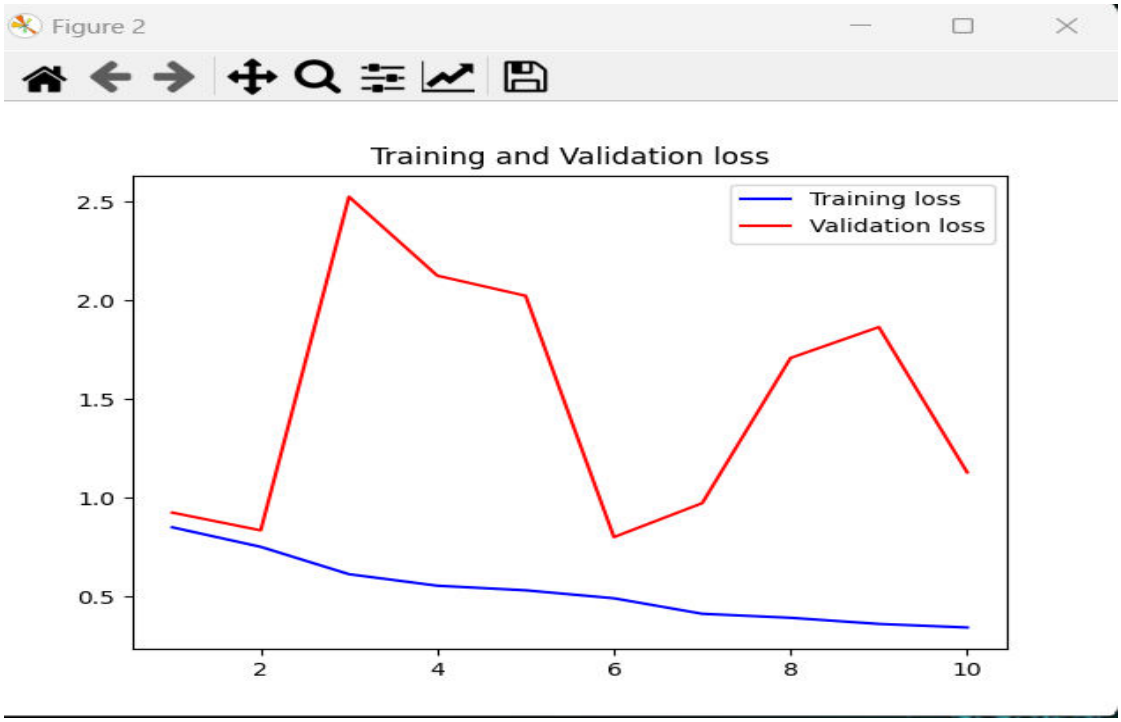
Output: The output refers to the final prediction made by the model regarding whether a person's fingerprint belongs to a "crime" or "not crime" category. This output is determined based on the features extracted and learned by the CNN model from the input fingerprint image.This output can be used to identify individuals associated with criminal activities, link fingerprint evidence to potential suspects, and provide valuable information for forensic analysis and law enforcement efforts.

7. EXPERMENTAL RESULTS

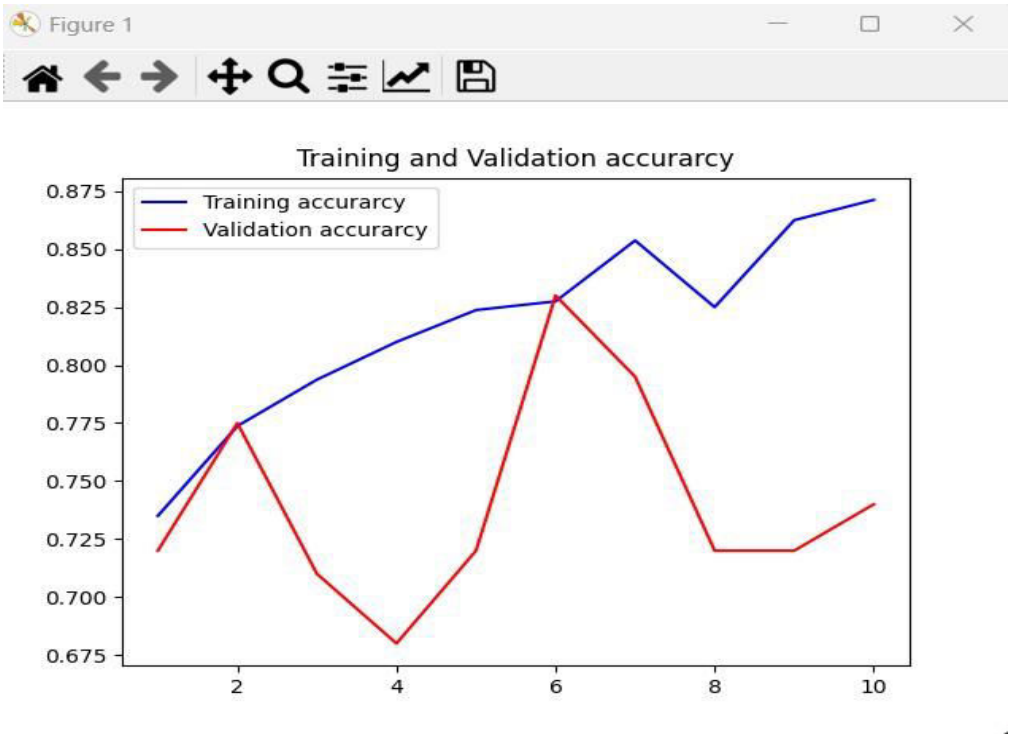


Login for Fingerprint Image Identification for Crime Detection

Building Training Model & Crime Detection

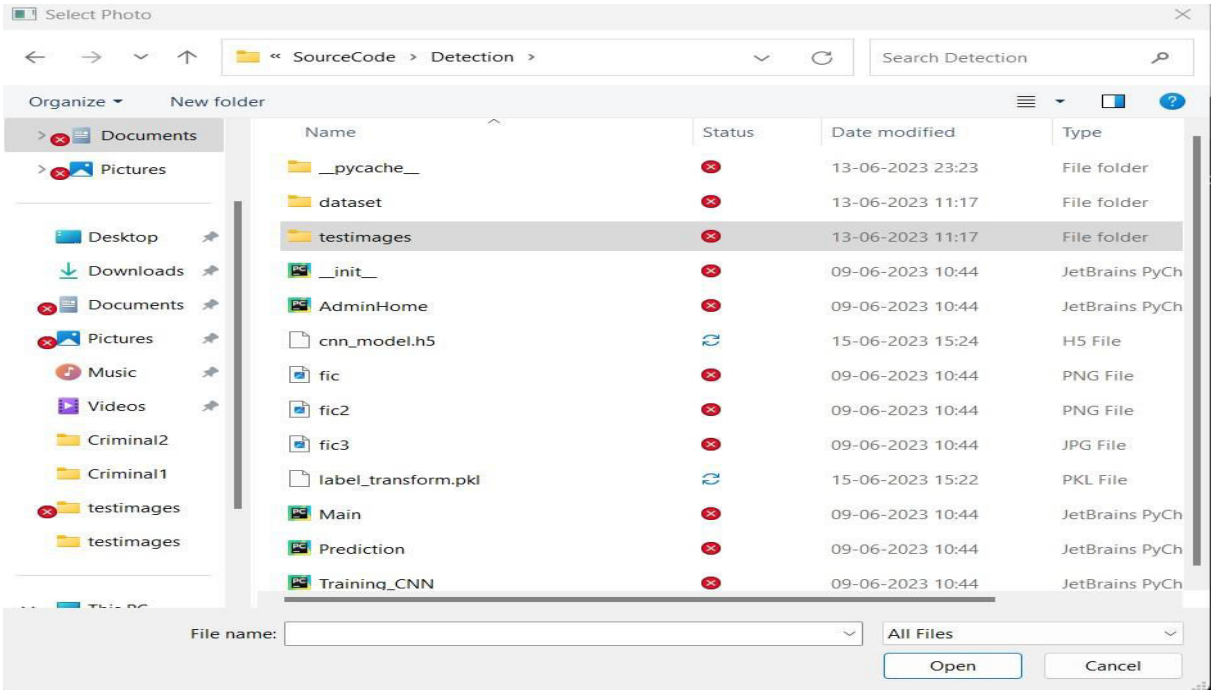


Graph for Training and Validation loss



Graph for Training and Validation Accuracy

Uploading Images for Crime Detection



Selecting Test Image Folder File Manager

Showing Result After Compilation of Detection

8. CONCLUSION

The proposed system is helpful to both user and federals. The system is developed considering all issues related to all users included. Variety of customers can use this system if they know how to operate the proposed system. The product is user friendly, low-cost and does not need any special training. Our scheme would prove time saving and ease for fingerprint recognition to many people using the system. The advantages of the system make it more robust.

9. FUTURE SCOPE

CNN-based fingerprint identification can be extended to forensic analysis, including latent fingerprint identification and analysis of partial or distorted fingerprint images. Research in this area can help develop techniques to extract valuable information from challenging fingerprint samples, aiding in criminal investigations.

Overall, the future scope for fingerprint image identification using CNNs for crime detection is wide-ranging, encompassing advancements in accuracy, efficiency, privacy, integration with other modalities, and forensic analysis. Continued research and development in these areas will contribute to the improvement of fingerprint identification systems and their application in real- world scenarios.

Currently, fingerprint identification using CNNs can be time-consuming, especially when dealing

with large databases. Future advancements may aim to develop faster algorithms and hardware optimizations to enable real-time or near real-time processing of fingerprint images.

10 REFERENCES

1) Kumar, N., & Vatsa, A. (2021). Deep Learning for Fingerprint Recognition: A Comprehensive Review.

2) Xia, L., & Zhu, L. (2021). Fingerprint Recognition Using Convolutional Neural Network with Attention Mechanism.

3) Dandawate, A. N., & Sontakke, S. M. (2020). Robust Fingerprint Matching Using Local Orientation and SIFT-Based Descriptors.

4) Mishra, P., & Sharma, V. (2020). A Comparative Study of Fingerprint Feature Extraction Techniques for Identification.

5) Khedher, M. K., et al. (2020). Deep Learning-Based Fingerprint Recognition: A Review.

6) Chen, H., et al. (2020). Fingerprint Identification Based on Deep Neural Network for Crime Scene Investigation.

7) Athithan, T. G., & Thyagharajan, K. T. (2020). Fingerprint Recognition System Using Hybrid Features Extraction.

8) Siddhartha, B., & Ramakrishnan, K. R. (2020). Object Detection in Crowded Scenes: A Survey. Journal of Ambient Intelligence and Humanized Computing, 11(3), 1143-1163.

9) Singh, A., & Kumar, A. (2021). A Survey of Deep Learning Techniques for Image and Video Analysis in Forensics. Journal of Ambient Intelligence and Humanized Computing, 12(2), 1273-1292.

10) Guo, Y., Zhang, L., Hu, Y., He, X., & Zhang, H. (2021). A Survey of Face Recognition in the Wild: Recent Advances and New Frontiers. ACM Computing Surveys, 54(5), 1-39.

11) Prasad, R. N., Zaveri, T., & Gandhi, T. (2022). Real-Time Object Detection in Surveillance Videos: A Comprehensive Survey. Journal of Ambient Intelligence and Humanized Computing, 13(2), 1877-1906.

12) Waghmare, R., & Halarnkar, P. (2022). Fingerprint recognition using texture-based approachfor crime investigation. In 2022 IEEE International Students' Conference on Electrical, Electronics and Computer Science (ISCES) (pp. 1-5). IEEE.

13) Zhang, Q., & Yang, J. (2021). Fingerprint recognition based on improved matching algorithm and deep learning. In 2021 IEEE 5th Information Technology and Mechatronics Engineering Conference (ITOEC) (pp. 423-427). IEEE.

14) Bansal, P., & Choudhury, M. A. (2021). Fingerprint recognition using deep learning for crime scene investigation. In 2021 IEEE Calcutta Conference (CALCON) (pp. 9-12). IEEE.

15) Arora, S., & Bharadwaj, K. K. (2021). Fingerprint matching for crime scene investigationusing deep learning. In 2021 4th International Conference on Intelligent Sustainable Systems (ICISS) (pp. 33-38). IEEE.

WEB-SITES

1) https://www.nist.gov/itl/iad/image-group/products-and-services/automatic-fingerprint-quality- afis-afiq/nist-fingerprint

2) https://www.ncjrs.gov/pdffiles1/nij/225320.pdf

3) https://www.theiai.org/

4) https://www.swgfast.org/

5) https://www.csofs.org/Latent-Fingerprint-Examination